we see, that the 18·4 parts of benzene require 56·8 parts of oxygen for the oxidation of their carbon and hydrogen to carbonic acid and water. This oxidation or combustion takes place at the moment of explosion at the expense of the 56·8 parts of oxygen, contained in the rest of the mixture—the 81·6 parts of nitric peroxide. No other explosive now in use (including blasting gelatin) contains weight for weight a greater amount of combustible matter, and as an explosion of *these* bodies is simply a sudden combustion, I again beg to draw attention to the fact that the oxygen available for combustion in gun-cotton is most probably not more than 32·3 per cent. and in nitroglycerin 42·3 per cent.,[1] while in this case we have without a doubt 56·8 per cent. Hence no other explosive now in use can rival this and similar mixtures in power, as I published in 1873. They still remain *the most powerful* explosives known.

"It hardly need be said that an explosive of this nature consists of two parts—an oxidising and a combustible agent—and that Mr. Turpin with the same *naïveté* lays claim not only to the first, but also to the latter half of the subject.

"None of my *safety*-explosives are licensed in England, though many of them, when mixed, are much less sensitive to concussion than common gunpowder.

"In April 1884 the French military authorities were busy near Rochefort with shells of the 'système Turpin.' These shells, so my informant said, were made of such a size, and possessed such a prodigious power, that a ship struck by one of them would inevitably be sent to the bottom of the sea, even were she the strongest ironclad afloat. It is devoutly to be hoped that those whose office it is to provide for the defence of the British Navy *will be ready* in the hour of need to serve out shells, filled with an explosive of equal force or better still with something superior, approaching more closely the 'beau idéal.'"

MR. VERBEEK ON THE KRAKATÃO DUST-GLOWS

As it appears from the letter of Mr. Douglas Archibald in NATURE of April 29 (p. 604) that some doubt exists as to the quantity of volcanic dust ejected during the Krakatão eruption in 1883, it may not be inopportune to give an abstract of what Mr. Verbeek—the best authority on the subject—says in the second part of his book. The mistake in the number of cubic kilometres—which Dr. Riggenbach or his critic magnified from 18 into 150—may possibly have arisen from the comparison Mr. Verbeek draws between the quantity of volcanic substances ejected by the Tambora in 1815 and that ejected by Krakatão.

Junghuhn estimated the quantity of ashes ejected by the Tambora in Sumbawa at 318 cubic kilometres, but Mr. Verbeek reduces it by calculation to about 150, though he adds that the data are insufficient to form a really correct estimate. It is certain, however, that the quantity was considerably larger than that ejected by Krakatão. To calculate this quantity Mr. Verbeek made observations everywhere on the islands and along the coasts of the Straits of Sunda; while the thickness of the ashes which fell into the sea was computed according to the difference in the depths of the sea before and after the eruption, a difference which greatly varies, and amounts in some places to 40 metres, if not more. Wherever some doubt exists for want of previous accurate deep-sea soundings, Mr. Verbeek gives the lowest figures. These observations are all illustrated by maps. Mr. Verbeek estimates the quantity of ejected material which fell round the volcano at 18 cubic kilometres at least. The possible outside margin would, however, not exceed 3 cubic kilometres. Of this quantity, two-thirds, or 12 cubic kilometres, lies within a circle with a radius of 15 kilometres drawn round Krakatão, one-third, or 6 kilometres, outside it. Of the finer ashes a large quantity were already, during the first three days, blown into the sea, as appeared from observations made on ships; and Mr. Verbeek assumes that considerably less than 1 cubic kilometre remained floating in the upper regions of the atmosphere. This quantity would correspond to a layer of 0·002 millimetre thickness divided over the whole surface of the earth, or of 0·004 millimetre over the temperate zones only.

Such an infinitesimally thin layer could hardly have been the principal cause of the atmospheric phenomena. They must be accounted for in a great measure by the large volume of aqueous vapour ejected by Krakatão, the amount of which lies, unfortunately, beyond all calculation. We have to deal with two distinct phenomena, as Prof. Michie Smith also has shown by the two different spectra, and these phenomena had different causes: thus, the blue and green tints of sun and moon, which were specially observed during the first month after the eruption, and only in places close to the equator, must be principally ascribed to the *solid* particles in the volcanic ash-cloud, as various observations have shown that these are the main cause of the special absorption of the rays of light by which the sun appeared blue and green; the aqueous vapour may have increased the phenomenon, for it is known that the sun can look bluish through mist. It cannot be said to be a proof to the contrary that Mr. Lockyer saw the sun green through the steam which escaped from the funnel of a steamer, for probably a quantity of ash and soot-particles escaped from the funnel at the same time, and it is possible that the sun appeared green from that very fact. The steam was thus in the identical condition of our volcanic cloud. It was only in the beginning after the eruption, before the ashes had spread very far, and when, therefore, their density was greater, that they were able within a limited space to give green tints to the sun. This phenomenon ceased when the ashes were dispersed further round the globe—in the northern hemisphere by the south-west, in the southern hemisphere by the north-west winds—and when probably also a portion of them fell gradually on the earth.

The crimson after-glows which soon followed the eruption were observed *at the same time* over a much larger area than that within which the blue and green sun was seen at successive periods, and they are believed by Mr. Verbeek to have been caused mainly by the masses of aqueous vapour thrown out by Krakatão, and which formed the greater part of the volcanic cloud. This vapour, after condensing and freezing in the higher and colder regions of the atmosphere, produced the remarkably beautiful sunsets, while the ashes may have intensified the phenomenon, besides serving as a centre of condensation for the vapour. The real cause of the crimson glows was therefore probably the same as that of the evening red, their intensity being a consequence of the extraordinary quantity of vapour in the upper regions emitted by Krakatão.

THE PARIETAL EYE OF HATTERIA

Some little time ago, whilst engaged in work upon *Hatteria punctata*, I found a curious sense-organ embedded in the substance occupying the parietal foramen, but was unable at the time to examine the specimen further; Prof. Moseley has kindly directed my attention to a short paper published in the *Zoologischer Anzeiger* for March 29, 1886, by Von Henri W. de Graaf, "Zur Anatomie und Entwickelung der Epiphyse bie Amphibien und Reptilien," wherein are described briefly (1) the development of the epiphysis, and (2) the structure of this part in the adult animal in certain amphibia and reptiles. An examination by means of sections at once revealed the fact that in Hatteria the epiphysis becomes modified in a manner more interesting than that found by Von Graaf to obtain in *Anguis fragilis*—the most modified form described by him.

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[1] Of these, by the bye, only 38·8 per cent. can be utilised for want of fuel, as pointed out by me in my patent of 1871, and verified four years later by the force of Nobel's blasting gelatin, in which the excess of 3·52 per cent. oxygen is utilised by the dissolved gun-cotton, an explosive too rich in carbon. See Abbot's table, p. 17, in "The Hell-Gate Explosion near New York and so-called 'Rackarock,' with a few words on so-called 'Panclastite,'" by H. Sprengel. London: E. and F. N. Spon, 1886.

The epiphysis apparently arises as a hollow outgrowth from the roof of the third ventricle (region of thalamencephalon), and in both amphibia and reptilia becomes divided into two parts—a proximal one remaining in connection with the brain, and a distal bladder-shaped structure—the two becoming in most cases completely separated from each other. In *Anguis fragilis* Von Graaf finds that the distal part loses all connection with the brain, and develops into a structure resembling a highly organised invertebrate eye with, however, the important and curious exception that no nerve is present.

In Hatteria a still more interesting modification takes place, the distal portion being, as in Anguis, modified to form an eye; but this, unlike that in the latter, is provided with a well-marked nerve.

Fig. 1 shows the structure of the eye. The whole is enclosed in a capsule of connective tissue (C); anteriorly a lens (L) is present, composed of cells whose nuclei are very distinct. The lens forms the anterior boundary of a vesicle, the walls of which are formed from within outwards of the following layers:—(1) a layer which is not well marked (X), and which may possibly be due to the shrinkage and clinging to the walls of the contents of the vesicle, fluid in life; (2) a layer of rods (R) embedded in dark brown pigment, the pigment being specially developed anteriorly at the part indicated by the letter K; (3) a double or even triple row (I N) of nuclei; (4) a clear layer (M) which scarcely takes stain, and may be called the molecular; and (5) an outer layer (E N) of nuclei two or three rows deep.

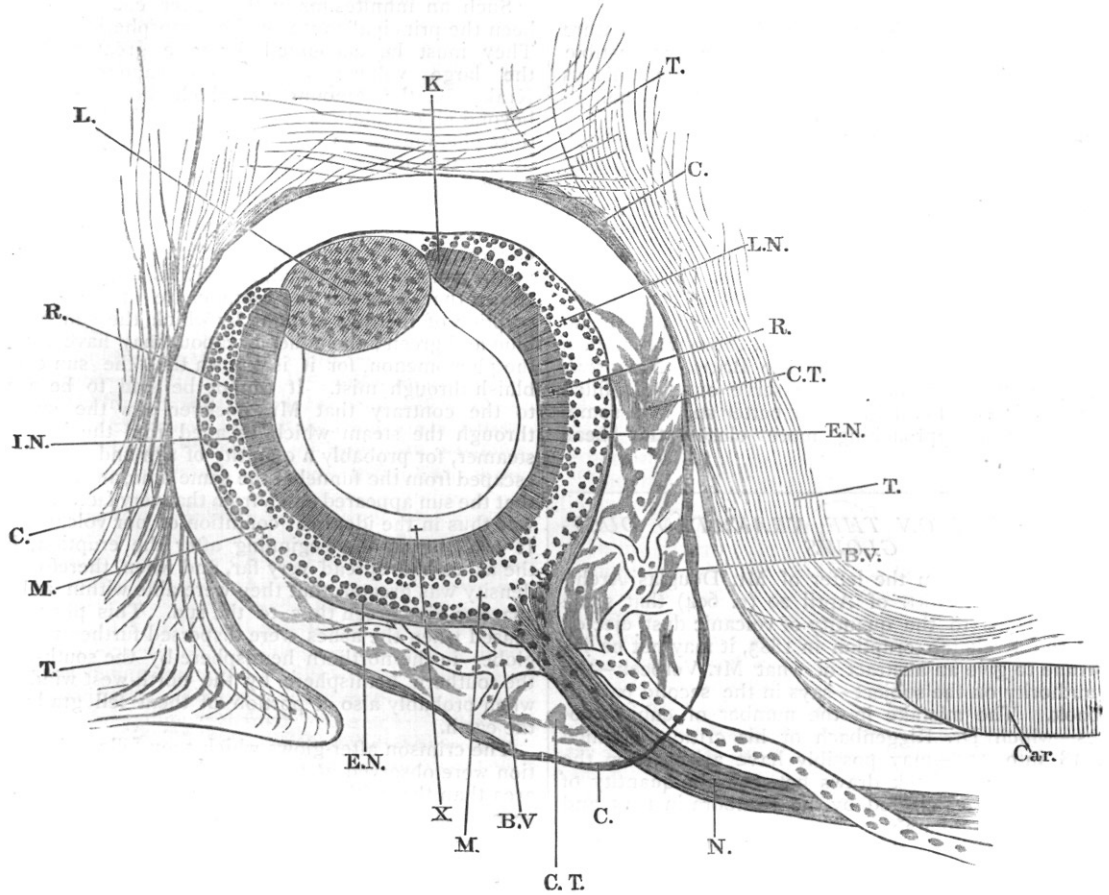

FIG. 1.—Longitudinal vertical section of parietal eye of *Hatteria punctata*.

This structure will, so far, be seen to correspond closely with that of Anguis.

Posteriorly a nerve enters the eye, the fibres spreading round behind the vesicle; the rods may be observed giving off processes from their external ends, which in some cases appear to pass right through the layers (3), (4), and (5), and in others to be connected in their passage with the nuclei of these layers.

However, I hope in a very short time to publish a detailed account of the histological structure of the organ.

The capsule containing the eye is filled posteriorly with connective tissue (C T), in which breaks up and ramifies a blood-vessel which enters along with the nerve (B V).

Fig. 2 represents somewhat diagrammatically a section transverse to the parietal foramen, showing that the eye is single and lies exactly in the median line. A depression of the skin of the head occurs immediately over the parietal foramen, but does not lead down into this, which is filled up by a plug of connective tissue (Fig. 1, T, Fig. 2, P T), specially dense (D T) around the eye capsule. The nerve is single, and leads downwards and backwards in the median line, being enveloped in the tissue passing from the foramen directly to the roof of the thalamencephalon.

I have not yet actually traced the nerve itself into the brain, but it is difficult to imagine that it can possibly arise as a branch from a cranial nerve, being *single* and *medianly placed*, and, as just said, enveloped in the material running directly to the roof of the brain from the foramen.

There can be little doubt that it represents the stalk connecting the distal with the proximal outgrowth from the roof of the thalamencephalon, this part having apparently disappeared in other reptiles and amphibia (so far as is yet known).

This being the case it is extremely interesting to observe that another instance will be added to that of the optic nerves in which an, at first, hollow outgrowth from the brain becomes solid and transformed into a nerve, and further that the latter, as in the former case, is connected with an organ of vision.

Though it is difficult to imagine what can be the use of the organ in its present state, seeing it is deeply embedded in connective tissue—so deeply as almost to preclude the idea of its being affected by light—yet it is important as showing in the same animal eyes developed in both the vertebrate and invertebrate type as regards the arrangement of the layers.

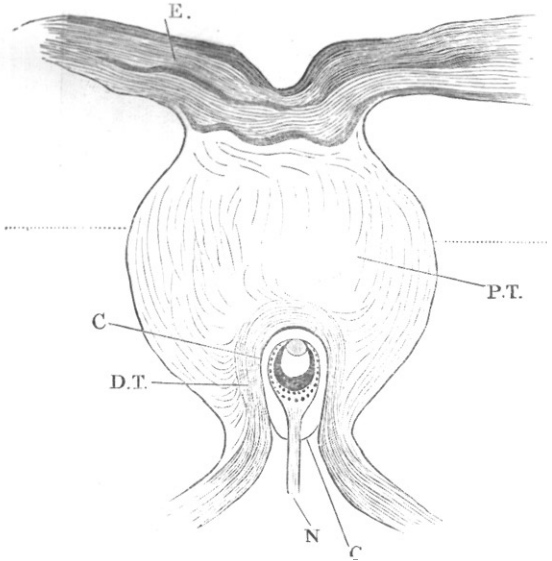

FIG. 2.—Transverse section through parietal foramen of *Hatteria punctata*. The part below the dotted line is situated within the parietal foramen.

In connection with this subject, it is perhaps of interest to point out that in formation of the paired eyes invagination to form an optic cup takes place, whilst apparently it does not do so in the case of what may be called the *parietal eye*. A little consideration shows that the relative position of the rods depends entirely upon this invagination. In both cases they are formed upon the inner surface of the wall in the position corresponding to the epithelium of the neural canal: but in the one instance they are, by decay of the outer wall of the invaginated cup, placed apparently on the outside of the optic vesicle; whilst in the other instance they are formed in a similar position, but, as no invagination takes place and subsequent decay of one wall, they line the cavity of the vesicle. According to this we must suppose that the part of the wall where the lens is present has either disappeared or become modified into this.

We may further observe that in both types of eye the nerve enters into connection with the elements on the surface opposite to that on which the rods are developed.

In conclusion my thanks are due to Prof. Moseley for his kindness in drawing my attention to the subject, and to Mr. E. B. Poulton, of Keble College, Oxford, who kindly placed two specimens of Hatteria at my disposal, and to Mr. Beddard, of the Zoological Society, for the use of another specimen. W. BALDWIN SPENCER

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NOTE.—Since writing the above I have found the eye present in several other lizards, notably in Iguana, *Chameleo vulgaris* and *Lacerta ocellata*, and have traced the nerve into the proximal part of the epiphysis.

ASTRONOMICAL PHOTOGRAPHY[1]

SOME attempts made last year at photographing the heavens by means of an instrument quite rudimentary having yielded good results, the director of the Paris Observatory gave orders for the construction of a special apparatus, the design of which is shown in the accompanying figure (Fig. 1). The mechanical part has been executed in a highly remarkable manner by our accomplished artist, M. Gautier; the objective is our own production.

This new instrument is composed of two telescopes in juxtaposition inclosed in a single metallic tube in the form of a parallelopiped, and separated from each other along their whole length by a narrow partition.

One of the object-glasses, with an aperture of 0·24 m. and a focal length of 3·60 m., is intended for eye observation, and serves as a pointer. The other, with an aperture of 0·34 m. and a focus of 3·43 m., is achromatised for the chemical rays, and serves the purpose of photography. The optical axes of these two objectives being parallel, every star kept in the centre of the field of the eye-piece belonging to the first telescope produces its impression in the centre of the sensitive plate of the photographic apparatus.

The equatorial is mounted in the form called English, that is to say, the centre of the tube rests always in the polar axis of the instrument. This arrangement allows of a star being followed from its rising to its setting without involving the necessity of bringing the instrument back to the vicinity of the meridian. Like a common equatorial it is furnished with hour circle and circle of declination, and with a clock movement keeping the apparatus in operation for three hours without fresh remounting. There are, moreover, independent very slow movements, whereby the axis of the telescope can be kept on a fixed point in the heavens, notwithstanding some slight irregularity in the movement of the clockwork, the orientation of the telescope, or the variations of atmospheric refraction.

The photographic objective—the largest ever yet produced—is formed according to a simple achromatic system, and, though of an extremely short focal length, is able, without the use of any diaphragm, exactly to cover the very considerable field of 3° diameter.

Although but very recently mounted, this apparatus has already availed for the performance of numerous tasks. On star photographs it is possible to distinguish traces of stars of the 15th magnitude, too feebly marked, however, to bear transference on paper. The stars of the 14th magnitude are reproduced with a diameter of 1/40 of a millimetre.

It is obvious that such small points might be liable to be confounded with the impurities of the sensitive coating if the precaution is not taken to multiply the stationary points. Each star is formed by a group of three points constituting an equilateral triangle, each side of which is no more than 1/12 of a millimetre. To the naked eye these three points appear to merge into one, but on examining them with the aid of a somewhat

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[1] From an article by the Brothers Henry in *La Nature*.